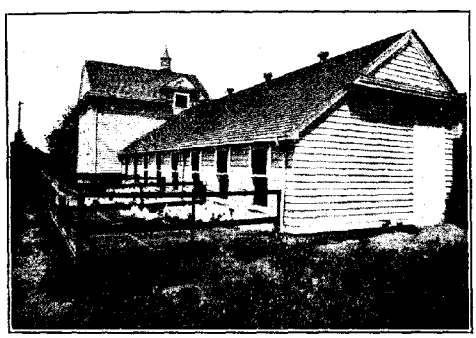
STATE COLLEGE OF WASHINGTON
AGRICULTURAL EXPERIMENT STATION
Pullman, Washington

Division of Poultry Husbandry

Methods of Feeding Leghorn Hens

by

J. S. Carver



GENERAL BULLETIN NO. 254

July, 1931

BOARD OF REGENTS

W. A. Ritz, President ..... Walla Walla, Wash.
Walter R. Rowe ..... Naches, Wash.
A. W. Davis ..... Spokane, Wash.
F. J. Wilmer ..... Rosalia, Wash.
J. H. Hulbert ..... Mount Vernon, Wash.
E. O. Holland ..... (President of the College, Secretary, ex-officio)

EXPERIMENT STATION STAFF

E. O. Holland, Ph.D., President
Edward C. Johnson, M.A., Director
Wm. C. Kruegel, B.A., Treasurer

Agricultural Engineering

[redacted]ith, M.E., Agricultural Engineer in Charge.
H. L. Garver, E.E., Investigator, Farm Electricity.[1]
P. C. McGrew, B.S., Associate Drainage Engineer, U. S. D. A.[2]

Agronomy

E. G. Schafer, M.S., Agronomist in Charge.
E. F. Gaines, D.Sc., Cerealist.[2]
A. L. Hafenrichter, Ph.D., Asst. in Farm Crops.
S. C. Vandecaveye, Ph.D., Soil Biologist.
L. C. Wheeting, Ph.D., Associate in Soils.
O. E. Barbee, M.S., Asst. in Farm Crops.
H. P. Singleton, M.S., Associate in Agronomy, Irrigation Branch Station, Prosser.
Carl A. Larson, M.S., Specialist in Irrigation Investigations, Irrigation Branch Station, Prosser.[2]
Harley Jacquot, B.S., Asst. in Agronomy, Adams Branch Station, Lind.
W. A. Rockie, B.S., Scientist in Soil Erosion, U. S. D. A.[2]

Animal Husbandry

Howard Hackedorn, B.S., Animal Husbandman in Charge.
Jerry Sotola, M.S., Asst. Animal Husbandman.

Chemistry

J. L. St. John, Ph.D., Chemist in Charge.
Otto Johnson, M.S., Assistant Chemist.
Kermit Groves, Ph.D., Assistant Chemist.

Dairy Husbandry

E. V. Ellington, B.S., Dairy Husbandman in Charge.
H. A. Bendixen, M.S., Associate Dairy Husbandman.
C. C. Prouty, M.S., Associate Dairy Bacteriologist.
J. C. Knott, M.S., Superintendent Official Testing.
R. E. Hodgson, M.S., Assistant Dairy Husbandman, Western Washington Experiment Station, Puyallup.

Entomology & Zoology

R. L. Webster, Ph.D., Entomologist in Charge.
Anthony Spuler, M.S., Assoc. Entomologist.
Arthur J. Hansen, M.S., Assistant Entomologist, Western Washington Experiment Station, Puyallup.

Farm Management & Agricultural Economics

....., Agric. Economist in Charge.
E. F. Dummeier, Ph.D., Agric. Economist.
Chester C. Hampson, M.A., Assistant Agricultural Economist.
E. F. Landerholm, M.S., Asst. in Farm Management.
Harvey W. Starling, B.S., Asst. in Rural Sociology.

Home Economics

Florence Harrison, A.M., Home Economist in Charge.
Evelyn H. Roberts, M.S., Research Specialist in Home Economics.
VeNona Swartz, M.S., Research Specialist in Foods and Nutrition.

Horticulture

E. L. Overholser, Ph.D., Horticulturist in Charge.
O. M. Morris, M.S., Horticulturist.
F. L. Overley, M.S., Associate in Horticulture, Wenatchee.
C. L. Vincent, M.S., Asst. Horticulturist.
L. L. Claypool, B.S., Asst. Horticulturist, Irrigation Branch Station, Prosser.
Max B. Hardy, M.S., Assistant.

Plant Pathology

F. D. Heald, Ph.D., Plant Pathologist in Charge.
L. K. Jones, Ph.D., Assoc. Plant Pathologist.
H. H. Flor, Ph.D., Assoc. Pathologist.[2]

Poultry Husbandry

John S. Carver, B.S., Poultry Husbandman in Charge.
Donald Brazie, Asst. Poultry Husbandman.

Veterinary Science

J. W. Kalkus, D.V.S., Veterinarian in Charge, Western Wash. Exp. Station, Puyallup.
C. E. Sawyer, D.V.S., Research Veterinarian, Western Washington Experiment Station, Puyallup.

Branch Stations

H. M. Wanser, M.S., Supt. Adams Branch Station, Lind.
H. P. Singleton, M.S., Superintendent, Irrigation Branch Station, Prosser.
D. J. Crowley, B.S., Specialist in Cranberry Investigations, Cranberry Investigations Laboratory, Long Beach.

---

[1] In cooperation with the State Committee on the Relation of Electricity to Agriculture.
[2] In cooperation with the United States Department of Agriculture.

TABLE OF CONTENTS

SUMMARY

From results of the work here reported and other experiments conducted at this station, reported by Cassel (1), it appears that laying hens do not require scratch grains fed in the litter either for exercise or maximum production.

The mash and scratch grain method of feeding with the scratch grain fed in limited amounts in hoppers proved fully as efficient as when the mash was fed in hoppers and the scratch grain in the litter.

The pellet method of feeding compared favorably with the all-mash method; but neither the pellet nor the all-mash methods gave as satisfactory results as either of the mash and scratch grain methods of feeding laying hens.

METHODS OF FEEDING LEGHORN HENS

By J. S. Carver*

INTRODUCTION

During the past few years many methods of feeding have been recommended to poultrymen of this section. One method about which there has been much discussion is the all-mash method of feeding where no scratch grain is fed to the laying hens. Several years of experimental work with all-mash laying rations have been carried on at this Experiment Station with varied results.

The hopper feeding of a scratch grain and mash ration to baby chicks has been successfully practiced in this state for several years, but very little information has been available in regard to the possibility of hopper feeding of scratch grain to laying hens as a supplementary feed to dry mash.

Another new method of feeding which has been recommended commercially in the past two years is the feeding of a compressed or pellet feed as a complete ration to laying birds. The all-mash ration is compressed under immense pressure into pellets or pills, each pellet being the same size and containing a complete balanced ration. A majority of the commercial poultrymen of Washington, however, are still feeding unlimited amounts of dry mash in hoppers, supplemented with several hand feedings of scratch grain fed in the litter at various times during the day.

It is the object of the feeding experimental work with laying hens at this station to select simple rations requiring a simple method of feeding that will produce maximum results in egg production.

* Acknowledgement is due former Assistant Professor L. W. Cassel of the Department of Poultry Husbandry for assistance and suggestions in carrying on this research.

The experiments reported in this bulletin were planned so that comparative data on the efficiency of the four methods of feeding now in use in this state might be obtained.

EXPERIMENTAL WORK

Time of Experiment. October 1, 1929 to September 30, 1930.

Housing and Yarding. All birds were housed in pens 15 x 12 feet, of identical construction, equipped with dark nests, two waste-proof dry mash hoppers, grit and shell hoppers, a green food hopper for feeding cut alfalfa hay, and two watering crocks. Each pen had an outside sun porch, 10 x 12 feet, with one-inch mesh wire floor provided to protect from worm infection.

Stock. Each pen contained 40 White Leghorn pullets hatched April 20, 1929, from the W. S. C. Experiment Station flock-mating Leghorns. No individually pedigreed high-line pullets were used in these experiments. The pullets were carefully selected and distributed among the four pens on the basis of uniformity, sexual maturity, body weight, and health.

Table 1. Rations

	Pen 1 W.S.C. standard laying ration scratch litter fed	Pen 2 W.S.C. standard laying ration scratch hopper fed	Pen 3 Mash and scratch ground and combined	Pen 4 Mash and scratch ground, combined and compressed
	pounds	pounds	pounds	pounds
Mash				
Wheat bran	200	200	280	280
Wheat middlings	100	100	140	140
Ground yellow corn	100	100	524	524
Fish meal	40	40	56	56
Meat meal	35	35	49	49
Bone meal	10	10	14	14
Ground oyster shell	10	10	14	14
Salt	5	5	7	7
Scratch				
Wheat	100	100	384	384
Cracked yellow corn	100	100		
Heavy oats	50	50	192	192

Rations. An unlimited supply of third-cutting alfalfa leaves and blossoms, cut in ¾ inch lengths, was kept before the birds in self-feeding hoppers. Fresh drinking water was furnished the birds at all times. Grit and shell were supplied ad libitum. Each lot was fed .8 of a pound of condensed buttermilk paste mixed with .0136 lbs. of Nopco XX cod liver oil, fed daily at 11 a.m. The rations are described in Table 1.

Methods of Feeding. The four different methods of feeding the W. S. C. standard laying ration are described below. The rations were computed on a basis of equal proportions of mash and scratch grain consumption in the four methods studied. The scratch grain intake was limited in Methods 1 and 2. In Methods 3 and 4 the same amount of scratch grain fed in Methods 1 and 2 was included in the mash and pellet rations.

Method 1

Unlimited dry laying mash hopper fed. Scratch grain fed twice a day in litter.

Feeding Schedule, Pen 1

7:00 a.m. 1¾ lbs. scratch grain
11:00 a.m. .8 lb. buttermilk emulsion
5:30 p.m. 3½ lbs. scratch grain

Cut alfalfa hay, grit and shell, and drinking water constantly before the birds.

Method 2

Unlimited dry laying mash hopper fed. Scratch grain fed twice a day in hoppers.

Feeding Schedule, Pen 2

7:00 a.m. 1¾ lbs. scratch grain
11:00 a.m. .8 lb. buttermilk emulsion
5:30 p.m. 3½ lbs. scratch grain

Cut alfalfa hay, grit and shell, and drinking water constantly before the birds.

Method 3

Granular all-mash ration consisting of a mixture of 42 per cent mash, the same as used in Pens 1 and 2, mixed with 58 per cent of the same scratch grain.

Feeding Schedule, Pen 3

7:00 a.m. Fill mash hoppers
11:00 a.m. .8 lb. buttermilk emulsion
5:30 p.m. Fill mash hoppers

Cut alfalfa hay, grit and shell, and drinking water constantly before the birds.

Method 4

The granular all-mash in Method 3 compressed in a Sizer pellet machine into pellets made into ¼ inch lengths, were fed in Method 4. Pellets were placed in hoppers and kept constantly before the birds.

Feeding Schedule, Pen 4

7:00 a.m. Fill hoppers with pellets
11:00 a.m. .8 lb. buttermilk emulsion
5:30 p.m. Fill hoppers with pellets

Cut alfalfa hay, grit and shell, and drinking water constantly before the birds.

Cost of Feeds. The costs of feed per hundred pounds were: W. S. C. laying mash, used in Pens 1 and 2: $2.59; the all-mash laying ration used in Pen 3: $2.36; the all-mash compressed in pellet form: $2.46; scratch grain used in Pens 1 and 2: $2.20; buttermilk emulsion, $4.56; grit, $1.10; oyster shell, $1.50; alfalfa hay, $1.00.

Price of Eggs. Prices used were based on the monthly average pool prices paid to members of the Washington Cooperative Egg and Poultry Association. These average prices per dozen per month are found in Table 2.

Table 2. Average Price of Eggs per Dozen (Dollars). 1929-30.

Month	Extras	Mediums	Pewees
October	.546	.384	.254
November	.505	.357	.250
December	.440	.341	.236
January	.342	.290	.230
February	.292	.254	.232
March	.270	.230	.210
April	.270	.215	.200
May	.255	.185	.175
June	.242	.172	.132
July	.245	.172	.120
August	.297	.215	.130
September	.365	.267	.160

DISCUSSION

It has been the previous experience in feeding of all-mash rations at this Experiment Station to encounter, during extremely cold weather, a decided drop in egg production. In this location each winter there will be several days of sub-zero weather. In past experiments, summarized in unpublished data of this Station, it has been found that, using mash and scratch grain method of feeding, it was possible to maintain high egg production during the extreme cold weather. With the all-mash ration, however, there was frequently a drop of from 20 to 30 per cent in production during the cold weather. It was hoped in this experiment that extreme, cold weather would be encountered during December or January that the several methods of feeding used might be put to a rigid test. Reference to Table 3, records that the most severe temperature for many years was encountered with a minimum temperature of 16 degrees below zero. During January there were 13 days below zero and two that were zero. The minimum inside temperatures of the laying pens during this period averaged from 25 to 30 degrees higher than the outside temperature, the minimum inside temperature being 12 degrees above zero on the coldest day.

Table 3. Temperature Records at Pullman, Washington During 1929-30 (Degrees Fahr.).

Month	Mean temperature	Maximum temperature	Minimum temperature
October	52.3	77	28
November	37.4	56	11
December	36.3	55	18
January	13.5	49	-16
February	38.5	57	24
March	40.0	66	20
April	49.8	76	33
May	52.7	84	32
June	58.3	85	40
July	68.9	94	43
August	69.5	91	46
September	59.2	87	38

The average number of eggs produced for the 12 months in Pen 1 was 237.69. Pen 2 had the highest egg production with 242.72 eggs. Pen 3, the all-mash pen, had the lowest production, with 218.33 eggs, and Pen 4, the pellet pen, had an average egg production of 222.51. The average number of eggs produced by each pen of pullets per month and the average for the year are found in Table 4.

Table 4. Average Number of Eggs per Pullet per Month and Average Per Cent Production per Month and Averages for Twelve Months, 1929-30.

Month	Pen 1		Pen 2		Pen 3		Pen 4	
	% Prod.	Av. No. of eggs	% Prod.	Av. No. of eggs	% Prod.	Av. No. of eggs	% Prod.	Av. No. of eggs
October	74.20	23.02	76.50	23.72	65.32	20.25	62.00	19.22
Nov.	76.90	23.07	68.73	20.62	75.60	22.70	63.50	19.06
Dec.	70.55	21.87	70.94	21.99	66.58	20.64	60.04	18.61
Jan.	60.28	18.68	65.65	20.35	58.43	18.11	55.75	17.28
Feb.	64.66	18.10	70.77	19.81	61.44	17.20	59.79	16.74
March	65.93	20.43	67.29	20.86	60.28	18.68	63.44	19.66
April	67.50	20.26	69.80	20.99	62.40	18.72	63.30	19.00
May	66.61	20.65	68.10	21.11	54.12	16.77	68.17	21.13
June	65.42	19.62	66.57	19.97	54.00	16.20	63.67	19.10
July	57.76	17.90	60.19	18.65	56.94	17.65	59.55	18.46
August	55.77	17.28	54.15	16.78	52.72	16.34	55.40	17.17
Sept.	51.92	15.06	56.11	16.27	41.97	12.17	53.25	15.44
Av. for 12 months	65.30	237.69	66.68	242.72	59.98	218.33	60.83	222.51

These results are just the reverse of those reported by Molyneux, (3) who secured an average egg production of 178.38 eggs from all-mash pens and smaller production of 169.87 eggs from the pellet pens. The higher egg production secured by the feeding of mash supplemented by scratch grain as compared to all-mash is verified by Kennard, et. al (2) who report an 11-months' production of 153 eggs for mash and scratch and 150 eggs for all mash.

The per cent production illustrated in Figure 1 in December for the all-mash pen was 66.58; in January when the extreme cold weather was encountered it was 58.43 per cent, a drop of 8.15 per cent. All

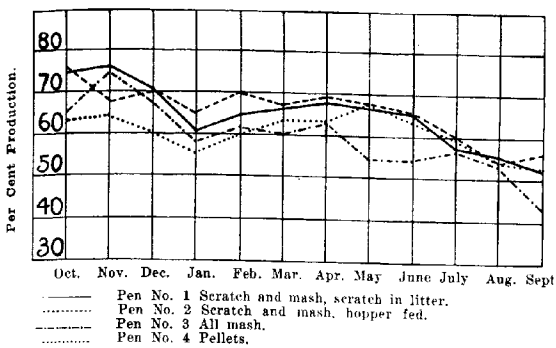


Fig. 1. Average per cent egg production by months, 1929-30.

of the pens showed a slight drop in production when they encountered the extreme cold weather of January, but recovered production in February. Pen 4, the pellet pen, showed the smallest drop in production with a loss of only 4.29 per cent, while Pen 1, receiving mash, and scratch fed in the litter, showed a loss of 10.27 per cent in January. Pen 2, mash and scratch hopper fed, showed a small drop in production of 5.29 per cent. The per cent production of the various pens for the year, as shown in Table 4 and Figure 1 are: Pen 1, 65.30 per cent; Pen 2, 66.68 per cent; Pen 3, 59.98 per cent; and Pen 4, 60.83 per cent. There was very little difference in the per cent production between Pens 1 and 2, the mash and scratch grain pens, and practically no difference in percentage between Pens 3 and 4, the all-mash and the pellet pens. The winter production was exceptionally high for all pens through the entire six months, with the all-mash and pellet pens producing less eggs during this period.

The amount of feed consumed by the different pens is shown by months in Table 5. The all-mash pen consumed less feed than the pellet pen through the entire experiment. This does not agree with Molyneux, (3) who secured greater consumption for the all-mash pen and less for the pellets. This was no doubt due to the fact that the pellet pen laid less eggs than the all-mash pen with the accompanying lower mash consumption; whereas, in this experiment, the pellet pen, laying more eggs than the all-mash pen, therefore had a greater feed

Table 5. Average Number of Pounds of Grain, Mash, and Pellets Consumed per Pullet per Month and Average for Twelve Months. 1929-30.

Month	Pen 1* W.S.C. standard laying ration scratch litter fed	Pen 2* W.S.C. standard laying ration scratch hopper fed	Pen 3 Mash and scratch ground and combined	Pen 4 Mash and scratch ground, combined and compressed
October	7.60	6.61	6.23	5.39
November	6.93	6.30	6.23	5.82
December	6.76	6.77	6.38	6.38
January	7.20	7.32	6.65	6.71
February	6.37	6.37	5.62	6.17
March	7.04	6.51	6.29	6.88
April	6.83	6.22	6.01	6.57
May	6.96	6.49	6.12	6.93
June	6.30	5.93	6.00	6.73
July	6.51	5.85	6.16	6.68
August	6.18	5.62	5.56	6.15
September	5.69	6.12	4.43	6.01
Av. for 12 months	80.37	76.11	71.68	76.37

* Mash and scratch added together.

consumption. The average feed consumption for the all-mash pen was 71.68 pounds per pullet for the twelve months, and for Pen 4, the pellet pen, it was 76.37 pounds, a difference of 4.65 pounds. Pen 2, fed mash and scratch grain in hoppers, consumed slightly less than the pellet pen, with 76.11 pounds consumed per pullet. Pen 1, with mash fed in hoppers and the scratch grain fed in the litter, consumed 80.37 pounds of feed. It would not appear that there was any economy to be secured in the feeding of all-mash or pellets. Although the consumption of feed was less with the all-mash, the production was also less. The small variation in feed consumption (which is accurately reported as the mash hoppers used in this experiment were waste-proof) would indicate that there was very little variance in the consumption of feeds as influenced by the methods of feeding. No doubt the difference in feed consumed depended almost entirely on the variability of the individual pullets in the experiment and rate of egg production.

Table 6. **Average Weight of Eggs per Dozen per Pen per Month and Average for Twelve Months in Ounces, 1929-30.**

Month	Pen 1 W.S.C. standard laying ration scratch litter fed	Pen 2 W.S.C. standard laying ration scratch hopper fed	Pen 3 Mash and scratch grounnd and combined	Pen 4 Mash and scratch ground, combined and compressed
October	18.84	19.02	18.84	19.34
November	20.06	20.17	20.23	20.06
December	21.56	21.68	21.64	21.77
January	23.14	23.27	22.98	23.13
February	23.77	23.99	23.82	23.69
March	24.11	24.35	24.47	24.13
April	24.46	24.45	23.57	23.77
May	24.08	24.04	23.01	23.95
June	23.60	23.40	22.47	24.10
July	23.70	23.08	22.64	23.61
August	23.59	22.92	22.50	23.91
September	23.45	24.20	23.44	24.96
Av. weight for 12 months	22.86	22.88	22.47	23.04

The average weights of eggs per dozen per pen were recorded daily in each of the four pens for the 12-month period. A detailed report of these weights by months is reported in Table 6. The average weight of the eggs for the 12 months in Pen 1 was 22.86 ounces. Pen 2 had almost identically the same egg weight with 22.88 ounces. In Pen 3, the all-mash pen, the eggs averaged considerably lower in weight with 22.27 ounces. Pen 4, receiving pellets, showed the greatest average weight of eggs per dozen per month for the 12 months with a weight of 23.04 ounces. The all-mash apparently did not produce as large eggs as the other methods of feeding; whereas, the all-mash in the pellet form produced larger egg size than any of the other three methods of feeding.

There was some variance between the different methods of feeding in the maintenance of the weight of the birds for the 12-month period. Table 7 reports the average weight of each pullet for each pen for 12 months in pounds. Pen 1 shows a slight loss of .09

Table 7. Average Weight per Pullet Every Month and Average Gain for Twelve Months in Pounds. 1929-30.

Month	Pen 1 W.S.C. standard laying ration scratch litter fed	Pen 2 W.S.C. standard laying ration scratch hopper fed	Pen 3 Mash and scratch ground and combined	Pen 4 Mash and scratch ground, combined and compressed
October	3.53	3.30	3.67	3.61
November	3.61	3.47	3.73	3.61
December	3.51	3.51	3.70	3.66
January	3.49	3.50	3.58	3.55
February	3.53	3.67	3.66	3.73
March	3.45	3.51	3.53	3.73
April	3.44	3.44	3.43	3.64
May	3.17	3.26	3.05	3.07
June	3.45	3.20	3.12	3.48
July	3.35	3.37	3.33	3.67
August	3.25	3.33	3.45	3.66
September	3.44	3.50	3.55	3.67
Av. gain for 12 months	-.09	.20	-.12	.06

pounds for the 12-month period. Pen 2 shows a gain of .2 of a pound, making the best gain of any of the different methods of feeding. Pen 3, the all-mash pen, showed the greatest loss with .12 of a pound loss from October 1 to September 30. Pen 4, receiving the all-mash ration in pellet form, showed a slight gain for the 12-month period of .06 of a pound. The loss in weight of some of the pens and the small gains in all of the pens may be accounted for by the extremely heavy production secured in all of the lots for the entire 12-month period.

The mortality by pens is presented in Table 8. The mortality in all of the lots was not influenced in any way by the methods of feeding or the ration fed. The average per cent mortality for Pen 1 was 27.50; Pen 2, 25.0; Pen 3, 27.50; and Pen 4, having the lowest mortality with 22.50 per cent. The most common causes of death encountered were: enlarged liver, ovarian diseases, prolapsus, internally broken eggs, and tumors. No colds or respiratory diseases were encountered throughout the entire experiment.

Table 8. Mortality per Pen by Months and Per Cent Mortality for Twelve Months. 1929-30.

Month	Pen 1 W.S.C. standard laying ration scratch litter fed	Pen 2 W.S.C. standard laying ration scratch hopper fed	Pen 3 Mash and scratch ground and combined	Pen 4 Mash and scratch ground, combined and compressed
October	....	....	....	....
November	1	2	....	....
December	....	....	....	....
January	....	....	1	1
February	....	....	....	....
March	1	1	1	....
April	....	....	3	....
May	1	....	1	1
June	1	3	3	2
July	2	2	2	3
August	2	1	....	1
September	3	1	....	1
Total	11	10	11	9
Per cent	27.50	25.0	27.50	22.50

Table 9. Average Return Over Feed Cost per Pullet for Twelve Months. 1929-30.

	Pen 1 W.S.C. standard laying ration scratch litter fed	Pen 2 W.S.C. standard laying ration scratch hopper fed	Pen 3 Mash and scratch ground and combined	Pen 4 Mash and scratch ground, combined and compressed
Av. no. of pullets	36.837	36.060	35.489	37.217
Av. cost of feed per pullet	$ 2.403	$ 2.291	$ 2.207	$ 2.380
Av. value of eggs per pullet	$ 5.717	$ 5.868	$ 5.280	$ 5.440
Av. cost of feed per doz. eggs	$ .121	$ .113	$ .121	$ .128
Av. return per pullet over feed cost	$ 3.314	$ 3.577	$ 3.073	$ 3.059

In all of the four methods because of the high production secured in each pen very excellent returns per pullet were made over feed costs. The average return over feed cost is reported in Table 9. Pen 1 shows a return per pullet over feed cost of $3.31. Pen 2, which had a higher production than any of the other pens, shows a profit of $3.57 per pullet over feed cost. The all-mash pen with the lowest production of any of the pens, had an average return per pullet over feed cost of $3.07, which was a greater profit per pullet than the pellet pen with an average profit of $3.05. The added cost of producing the pellets no doubt accounts for this higher cost of production. The measure of the efficiency of any ration for the poultryman is in the average return per pullet over feed cost.

The average cost of feed per dozen eggs is also reported in Table 9. In Pen 1, the average cost of feed per dozen eggs was 12.1 cents. Pen 2 had the lowest cost with 11.3 cents, and Pen 3 had identically the same cost as Pen 1, with 12.1 cents. Pen 4, showed the highest cost of feed per dozen eggs produced with an average cost of 12.8 cents.

LITERATURE CITED

1. Cassel, L. W. Feeding Experiments with Leghorns. Wash. Agr. Exp. Bul. **210**: 31. 1927.
2. Kennard, D. C., and Bethke, R. M. The All-Mash Method of Feeding Chickens. Bi-monthly Bulletin, Ohio Agr. Exp. Sta. **11**: 131. 1926.
3. Molyneux, H. M. Pellet and All-Mash Experiments. The Harper-Adams Utility Poultry Journal. **15**: 583. 1930.